



The Use of Emulsions to Stabilize Residuals of Dirty Bomb Attacks

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 - Greg Moron, New Mexico State University
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 - Torrey Turner, Terell Stewart, Barbara Extine, Kaimudi Attupatu





Dirty Bomb: Overview

- Radiological Dispersal Device
 - Small explosive which disperses radioisotopes
- Goals of Attack
 - Terror
 - Injury/Death
- Materials
 - Heavy isotopes: Uranium, Plutonium
 - Powdery materials: cobalt-60, strontium-90, cesium-137
 - Lower level materials: Carbon 14, Americium, radioactive nickel, wastes
 - Non-radioactive contaminants



Radioisotope Thermoelectric Generators (RTGs), a strontium-90 source





Dirty Bomb: Treatment

- Some contaminated areas may be “too hot” for immediate cleanup
 - Brazil X-Ray Incident
- Logistical difficulties may effect cleanup
 - Trade Center
- But migration of contaminants can exacerbate the problem
- Therefore, a stabilization technology may be useful
- Especially for military facilities



Simulation of dirty bomb attack Seattle, Washington



Emulsion Treatment

- Produced by Encapco Technologies, LLC
- Mixture of emulsified asphalt, tall oil pitch, water, acid, and chelating agents
- Tested for stabilizing soils contaminated with metals and radioisotopes (environmental applications)





Goals of Project

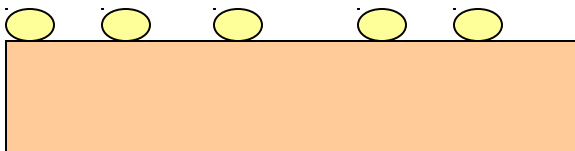
- Test the feasibility of emulsions as a means to stabilize residuals of dirty bomb attacks
- Optimize performance of emulsions for this application
- Develop a usable system within 1 year from now (1.5 years total)



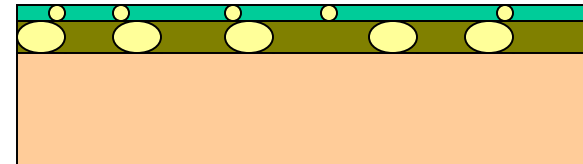
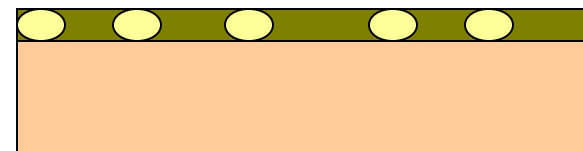
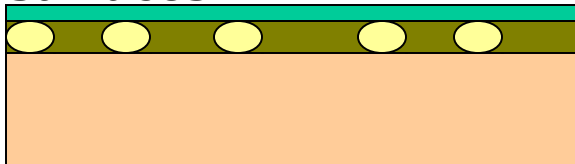
Within 3 years, expand to chemical and
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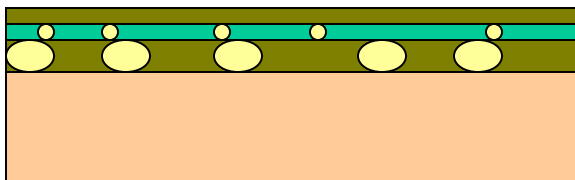
Concept



The attacked surfaces are treated with rapid setting emulsion to prevent migration of residuals settling on surfaces



Next, a layer of slow setting emulsion is added, to capture airborne particulates



Finally, a rapid setting cap is added



Eventually, the emulsions & contaminants are cleaned off the surface

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Stabilization

- Water
 - Submersion
 - Flowing
- Air
- Physical Disturbance





Background Experiments

- Permeability
 - Thin layers evenly spread of asphalt emulsion can reduce permeability of surfaces by orders of magnitude
- Setting time
 - Comparisons of setting times are documented for different emulsion types, under different environmental conditions
- Treatment of lead and iron simulants
 - Lead and iron used to simulate heavy isotopes (uranium and plutonium)
 - Emulsions very effective at stabilizing under both submersion and under fluid flow
 - Some reaction with certain building materials



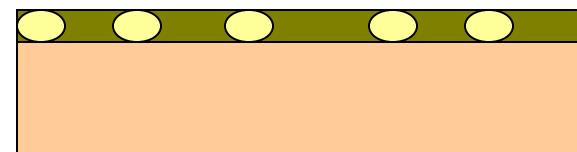
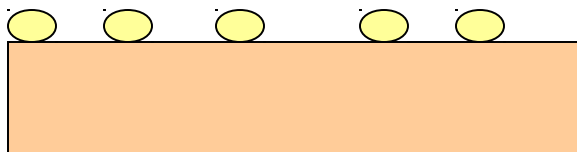


Potassium Chloride Stabilization Experiments

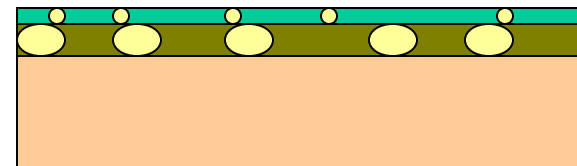
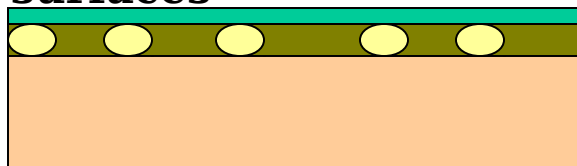
- Potassium chloride (KCl) was used as a simulant for cesium chloride
- Treat on building material surfaces: 5 cm x 5 cm
- Submersion
- Evaluation of stability
 - Emulsion - total organic carbon, suspended solids
 - Contaminant - conductivity, potassium



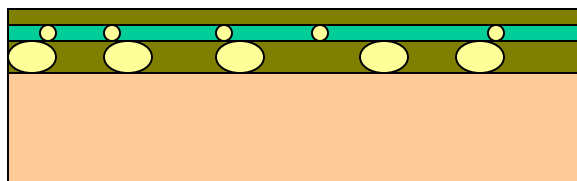
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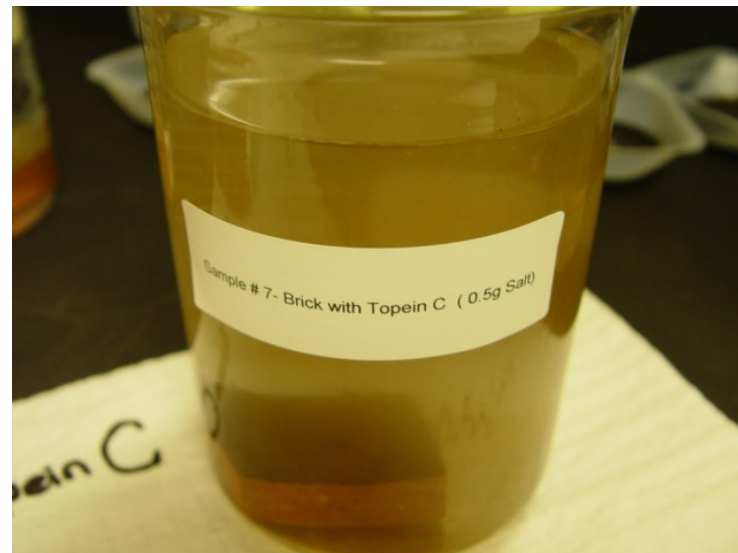
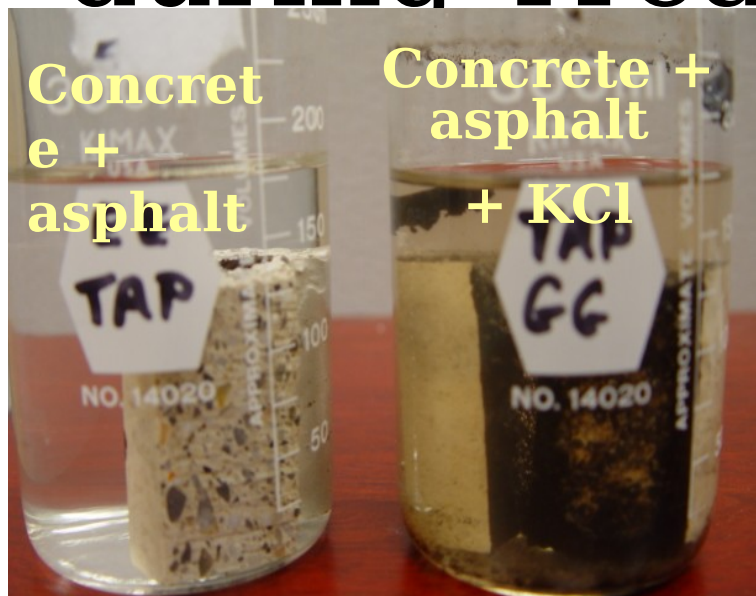


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Instability of Emulsion during Treatment of KCl

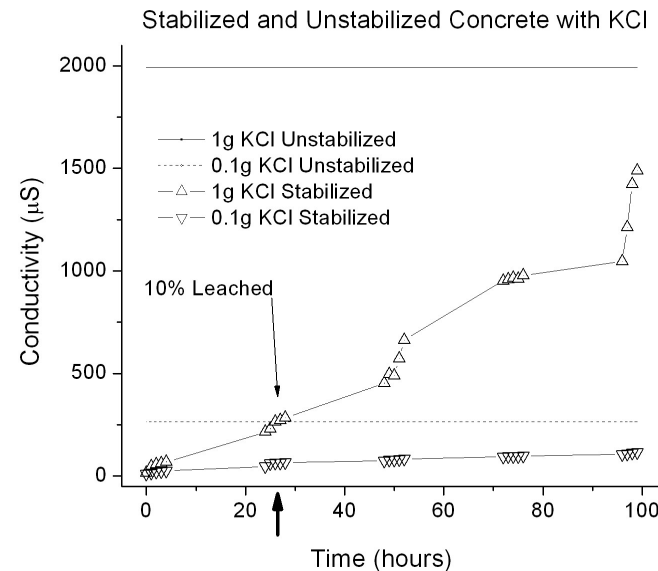
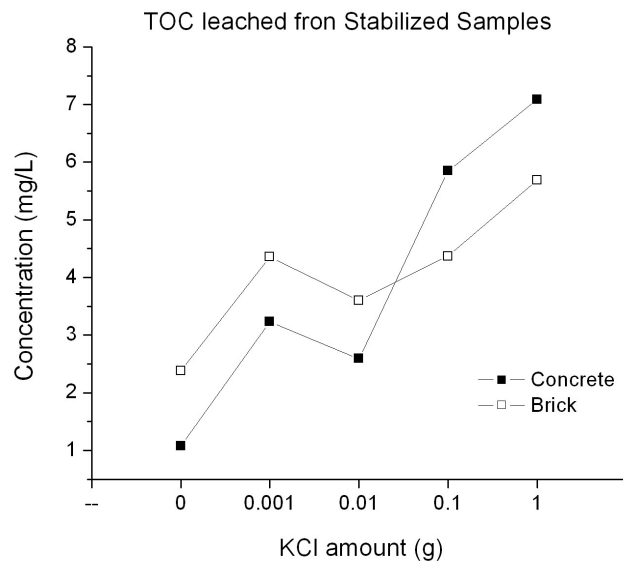


Breakup of the emulsion during treatment of KCl is clearly visible upon submersion.

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Measurements



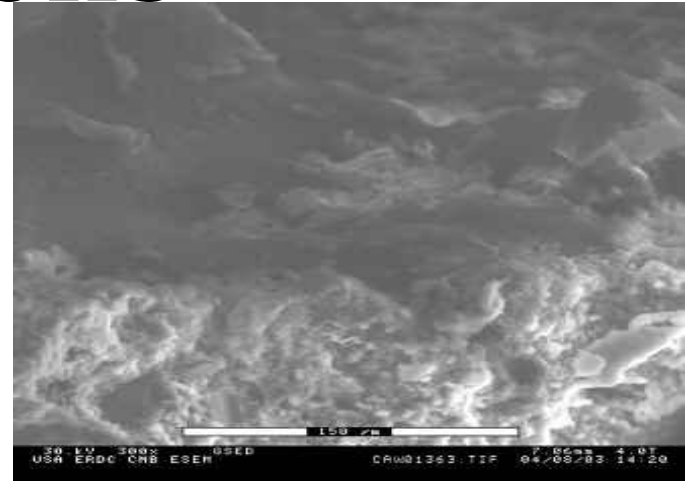
KCl mass is mass per 25 cm²

Total organic carbon measures erosion and the emulsification of the KCl. Conductivity measures escape of the KCl.

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Stabilization of KCl - Conclusions

- Potassium chloride was not stabilized against submersion and water flow
- KCl reacted with the emulsion, affecting its ability to set
- Emulsion clearly stripped off
- KCl escaped into solution
- So, we needed to solve this





Amendments

Additives (iron, bismuth, barium sulfate) added to emulsion, then applied

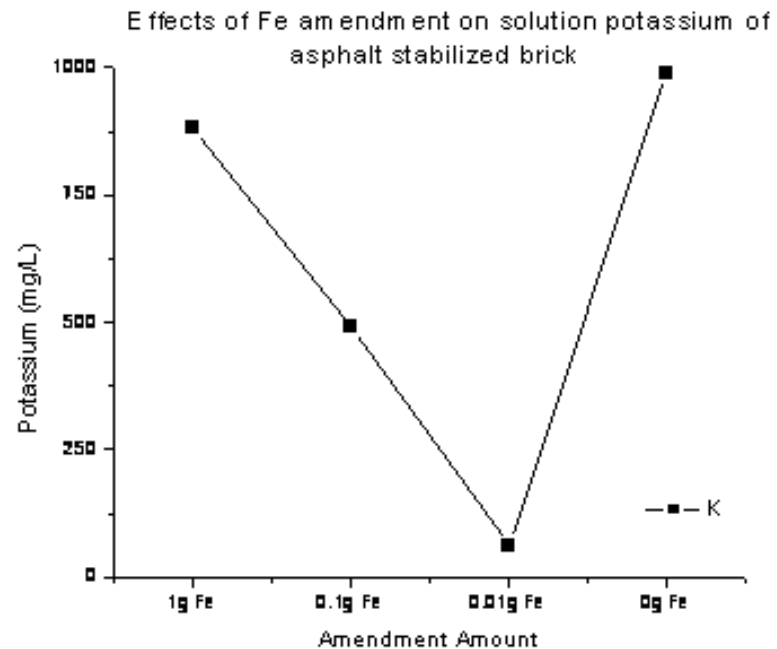
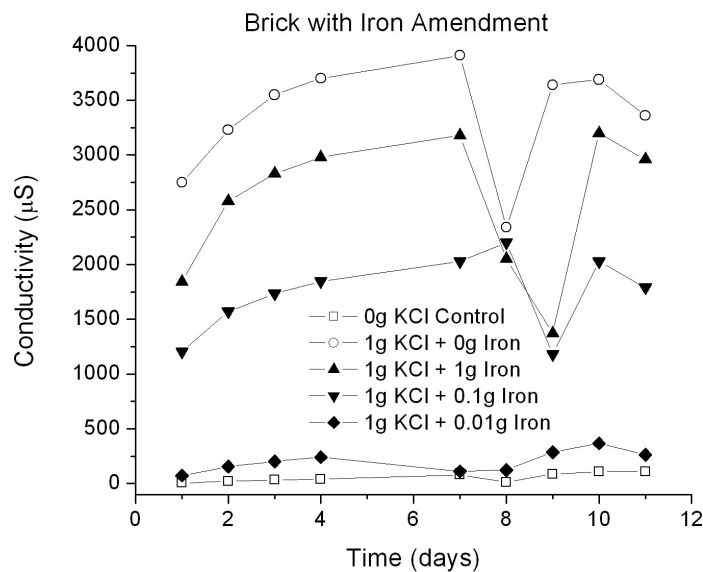


The pictures indicate that bismuth and iron dramatically
The visual effects of erosion. But the barium sulfate c



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Leaching of KCl into Solution



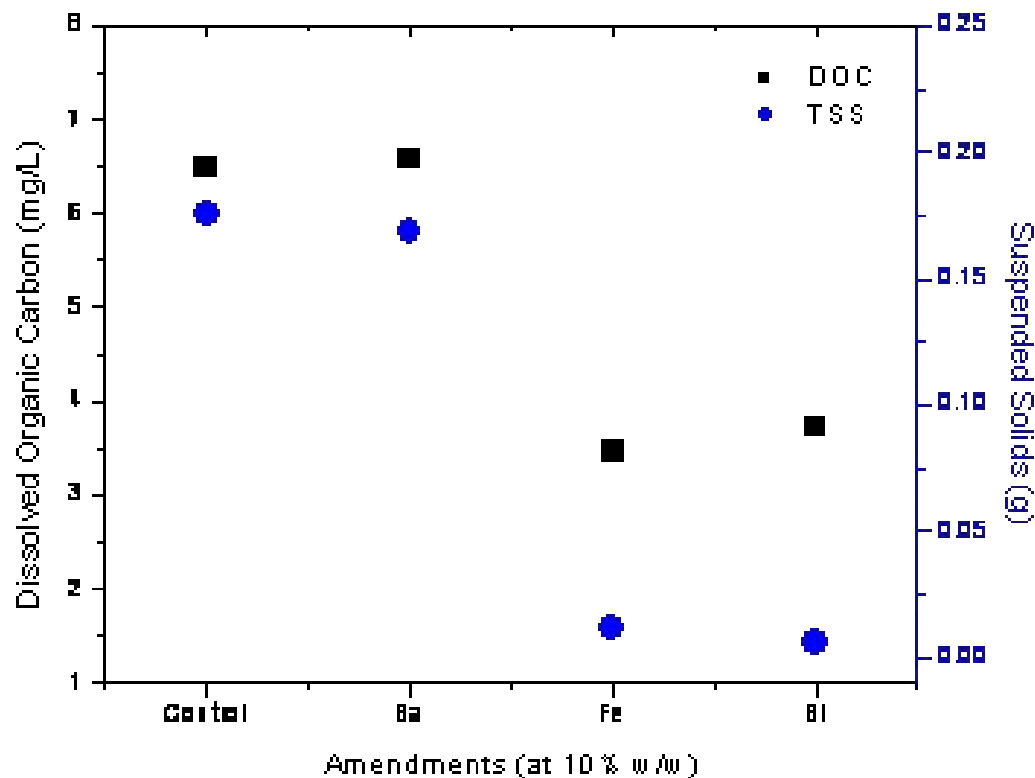
KCl mass is mass per 25 cm². Iron mass per g of emulsion. Iron amendment dramatically reduced conductivity in with emulsion on brick. K⁺ had a similar pattern





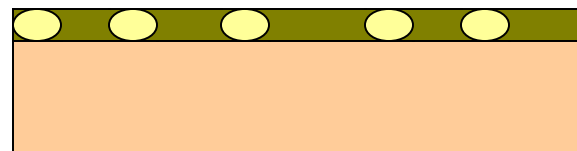
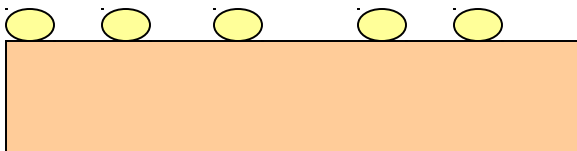
Stability of Emulsion

Effects of Amendments on Water Stability of Asphalt (Brick)

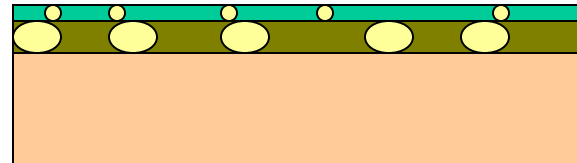
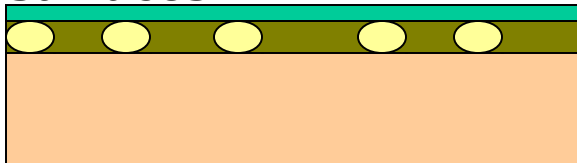




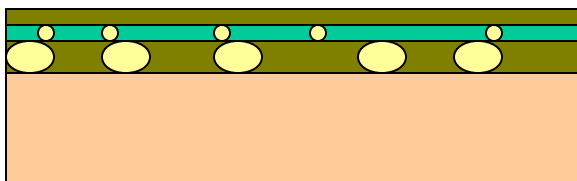
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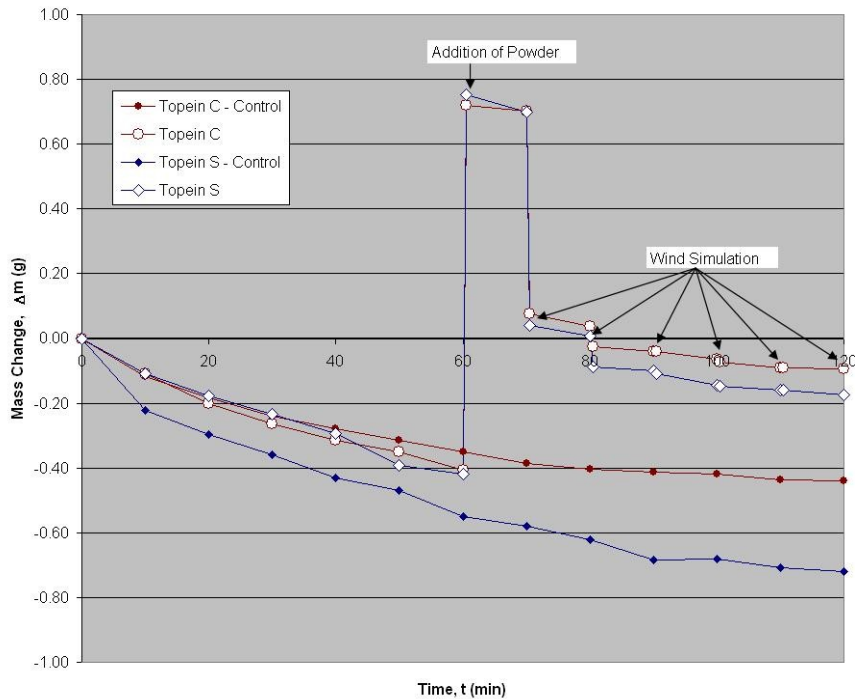
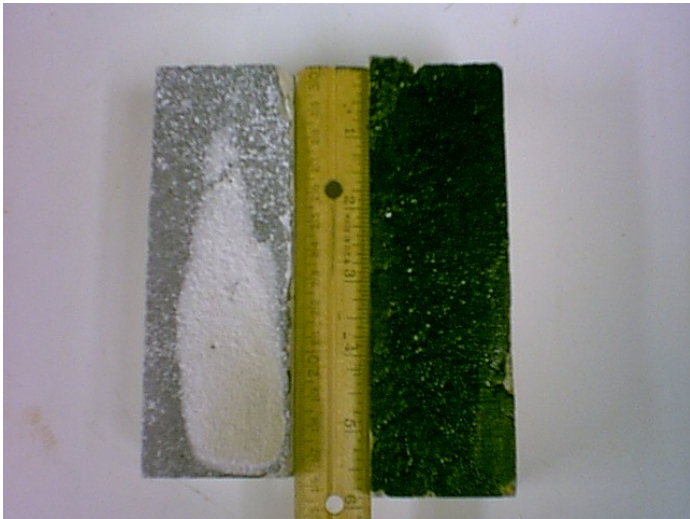


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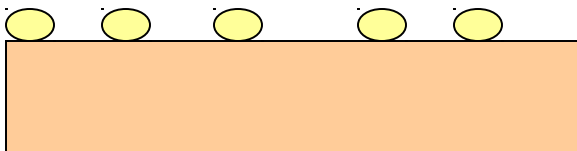


Results

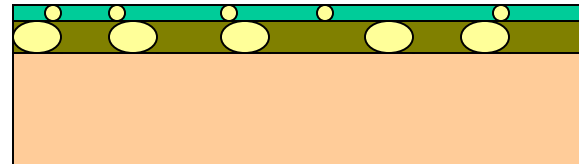
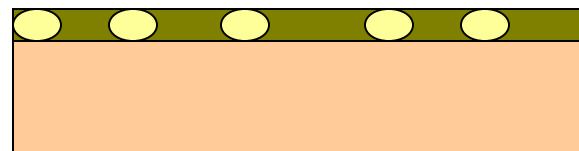
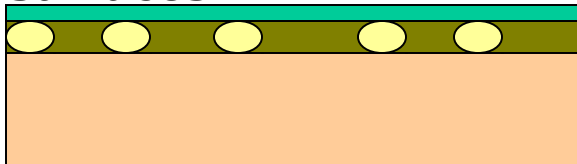




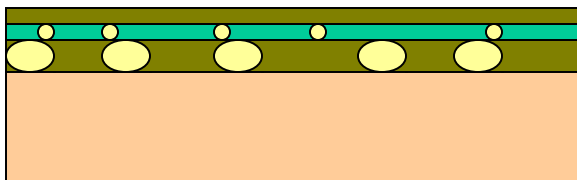
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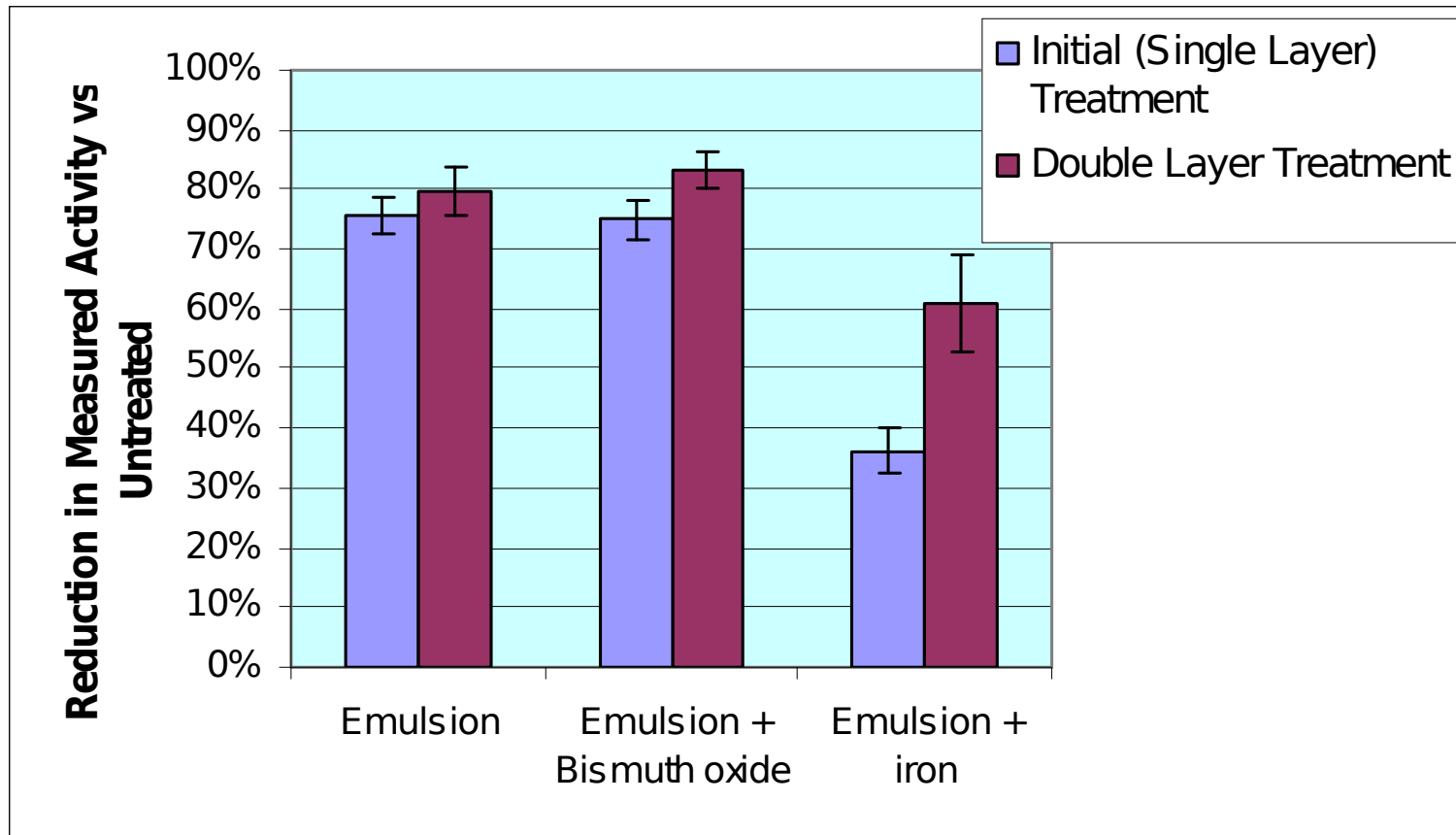
Shielding of Radioactivity

- Rationale
 - Asphalt caps at radioactive waste landfills
- Process
 - Treat radioactive strontium (β -emitter)
 - Initial activity - 5 counts per second
 - Compare to untreated bricks
 - Second treatment conducted & measured



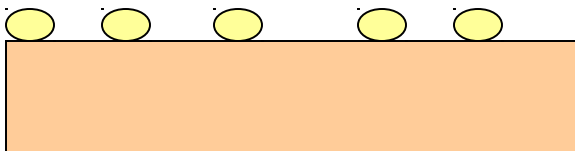


Reduction in Beta Activity After Treatment

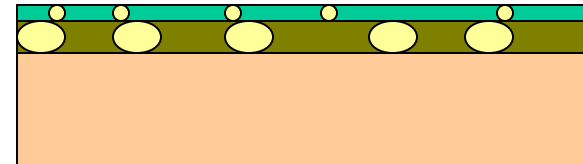
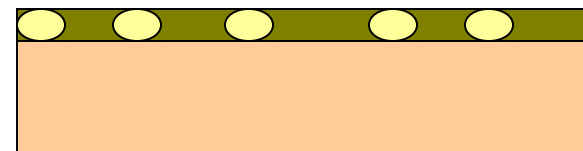
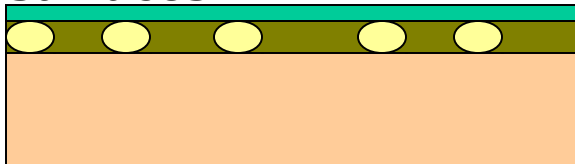




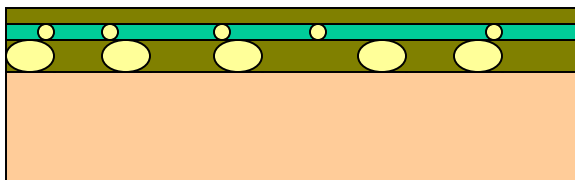
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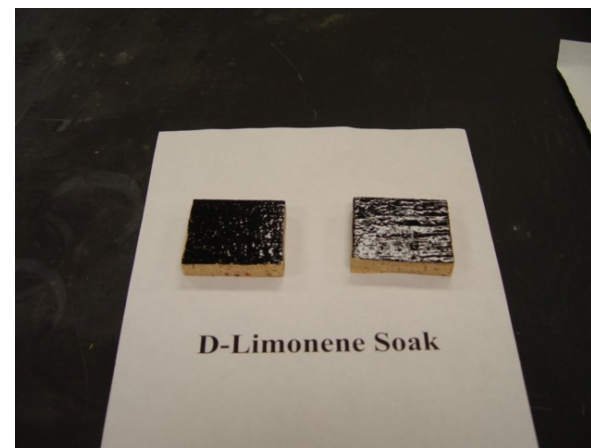


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Removal of Emulsion

- Rationale
 - The treatment is simply to stabilize the contaminants, eventually they will have to be removed.
- Mechanism
 - Exploring the use of a citrus solvent - d-limonene
- Experiment
 - Apply to treated surfaces, monitor removal





Summary

- Promising aspects
 - Trapping and retention
 - Amendments solved problems with KCl
 - Radiation shielding
 - Goal 1 - technical feasibility
- Challenges
 - Reactions with building materials
 - Appropriate use of amendments
 - Cleanup strategy
- Application strategy
 - Environmental applications





Next Steps

- Performance criteria
- New Formulations
 - Cationic and neutral
 - Amendments
 - Multistage
- Other materials
 - Dust suppression materials - Soil Sement™
(Midwest Industrial Supply, Inc.)
- Field tests





Questions

